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91164

NZQA

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Level 2 Chemistry, 2017

91164 Demonstrate understanding of bonding, structure, properties and energy changes

2.00 p.m. Thursday 16 November 2017
Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of bonding, structure, properties and energy changes.	Demonstrate in-depth understanding of bonding, structure, properties and energy changes.	Demonstrate comprehensive understanding of bonding, structure, properties and energy changes.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table is provided on the Resource Sheet L2–CHEMR.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Achievement

TOTAL **12**

ASSESSOR'S USE ONLY

hexo
pendo

QUESTION ONE

(a) When solid calcium chloride, $CaCl_2(s)$, reacts with water, the temperature increases.

Circle the term that best describes this reaction.

endothermic   **exothermic**

Give a reason for your choice.
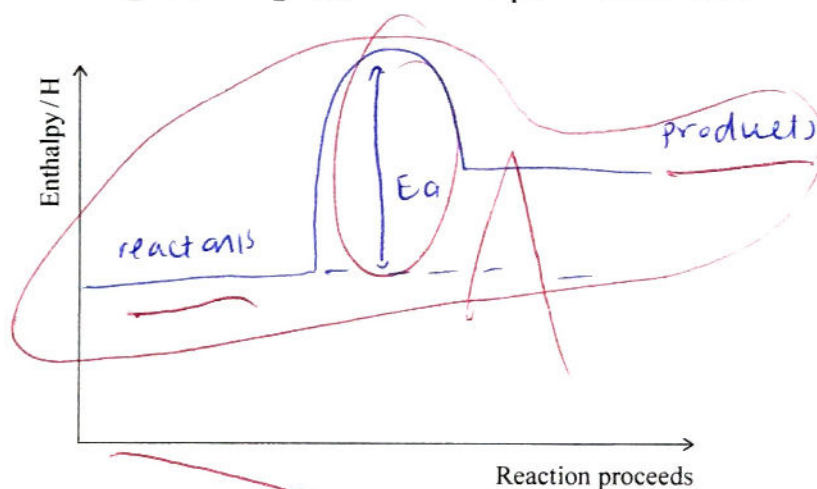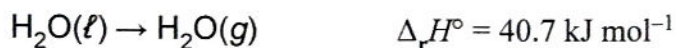
Energy is released as the temprature increases

(b) When a person sweats, water is lost from the body by evaporation. This is an endothermic process. This evaporation speeds up when a person exercises.

(i) Explain why the evaporation of water in sweat from the body is endothermic, and why exercise increases this evaporation.

Evaporation of water in sweat from the body is an endothermic reaction as it involves bonds breaking. as liquid bonds are ~~formed~~ broken to form gas bonds more for the sweat to evaporate

(ii) Draw a labelled enthalpy diagram for the evaporation of water, $H_2O(\ell)$.

$$H_2O(\ell) \rightarrow H_2O(g) \qquad \Delta_r H° = 40.7 \text{ kJ mol}^{-1}$$

Enthalpy / H

reactants

Ea

products

Reaction proceeds

ASSESSOR'S USE ONLY

(iii) Sodium chloride, NaCl, is another compound that is excreted from the body in sweat.

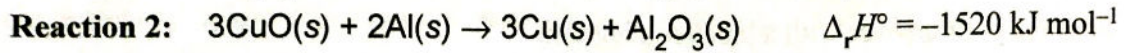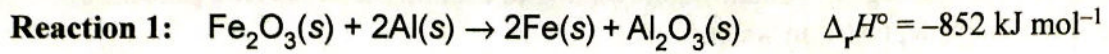Use your knowledge of structure and bonding to explain the dissolving process of sodium chloride, NaCl, in water.

Support your answer with a labelled diagram.

NaCl is an ionic substance made up of Na^+ and Cl⁻ held together by ionic bonds in fixed position. Ionic solids are made but up of oppositely charged particles held in fixed position in a 3D lattice. NaCl is an Ionic solid made up of Na^+ and Cl⁻ ions. NaCl is able to dissolve in water as water is a polar substance made out of H^+ and O^- ions. Therefore the slightly negative side δ⁻ O⁻ will be able to attract the Na^+ ions out of the 3D structure and the slightly positive side of water δ⁺ H^+ will be able to attract the Cl⁻ ions out of the structure, these forces are much stronger than the ionic forces that hold these particles together therefore is able to overcome it.

Space for diagram

(c)   Thermite reactions occur when a metal oxide reacts with a metal powder.

The equations for two thermite reactions are given below:

Reaction 1: $Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(s) + Al_2O_3(s)$ $\Delta_r H° = -852$ kJ mol^{-1}

Reaction 2: $3CuO(s) + 2Al(s) \rightarrow 3Cu(s) + Al_2O_3(s)$ $\Delta_r H° = -1520$ kJ mol^{-1}

Use calculations to determine which metal oxide, iron(III) oxide, $Fe_2O_3(s)$, or copper(II) oxide, $CuO(s)$, will produce more heat energy when 50.0 g of each metal oxide is reacted with aluminium powder, $Al(s)$.

$M(Fe_2O_3) = 160$ g mol^{-1} $M(CuO) = 79.6$ g mol^{-1}

$$n(Fe_2O_3) = \frac{50.0}{160}$$

$$0.312$$

$$n = \text{~~~~~} \, mol$$

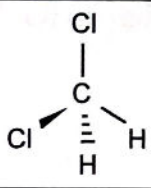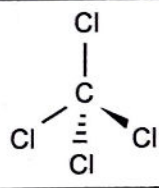$$n(CuO) = \frac{50.0}{79.6}$$

$$n = 0.629 \, mol$$

A4

QUESTION TWO

(a) (i) Draw the Lewis structure (electron dot diagram) for the following molecules, and name their shapes.

Molecule	HOCl	COCl$_2$	NF$_3$
Lewis structure	*(handwritten, crossed out)* H—$\overset{xx}{\underset{xx}{O}}$—$\overset{xx}{\underset{xx}{Cl}}$	*(handwritten, crossed out)* $\overset{xx}{\underset{xx}{Cl}}$—C=O	$\overset{xx}{\underset{xx}{F}}$—N—$\overset{xx}{\underset{xx}{F}}$ with F below N
Name of shape	~~Bent Trigonal pyramid~~ Bent	~~Trigonal~~ ~~Bent~~ Planar	~~Trigonal~~ Pyramid
Approximate bond angle around the central atom	109.5°	120°	109.5°

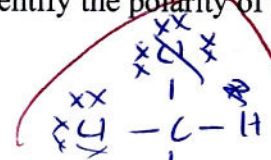(ii) Justify the shapes and ~~bond~~ angles of HOCl and COCl$_2$.

HOCl has ~~2~~ 4 regions of negative charge around the central atom 'O'. All repelling as far as way as possible to minimize repulsion. 2 of these are involved in bonding with ~~one~~ two non bonding pairs the bonded pairs resulting in a bent shape with angles of 109.5°. COCl$_2$ has 3 regions of negative charge around the central atom O. All repelling, all of these ~~bonds~~ pairs are involved in bonding. The bonded atoms resulting in a trigonal plana shape, with bond angles of 120°.

(b) Three-dimensional diagrams for two molecules are shown below.

Molecule	Cl—C (Cl, H, H)	Cl—C (Cl, Cl, Cl)
Name	Dichloromethane	Tetrachloromethane
Polarity of molecule	polar	non polar.

(i) In the boxes above, identify the polarity of each molecule, by writing either **polar** or **non-polar**.

(ii) Justify your choices.

Dichloromethane has 4 reigens of negative charge around the central atom C. All repelling. All 4 of these are involved in bonding. The bonded pairs resulting in a tetrahedral shape with angles of 109.5°. There is a difference in electronegativity around the molecule and there are polar bonds as Cl is more electronegative than C. These dipoles add giving an overall dipole therefore the molecule is assymetrical and polar. Tetrachloromethane has 4 reigens of negative charge around the central atom C. All repelling as far away as possible to minimise repullsion. There are polar bonds as Cl is more electronegative than C. However there is no difference in electronegativity around the outside of the molecule so the molecule is symmetrical and non polar.//

(c)   Hydrazine, N_2H_4, is used as rocket fuel.

Use calculations to determine which of **Reaction 1** or **Reaction 2** releases more energy.

Reaction 1: $N_2H_4(g) + O_2(g) \rightarrow N_2(g) + 2H_2O(g)$

Reaction 2: $N_2H_4(g) + 2F_2(g) \rightarrow N_2(g) + 4HF(g)$
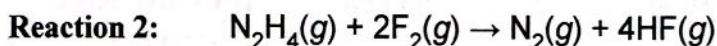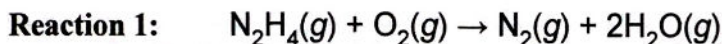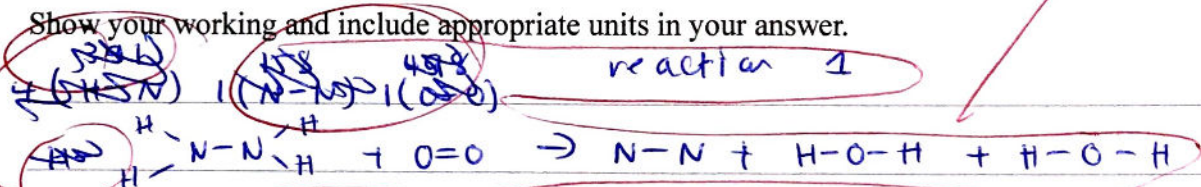
The structure of each chemical species is shown in the box below.
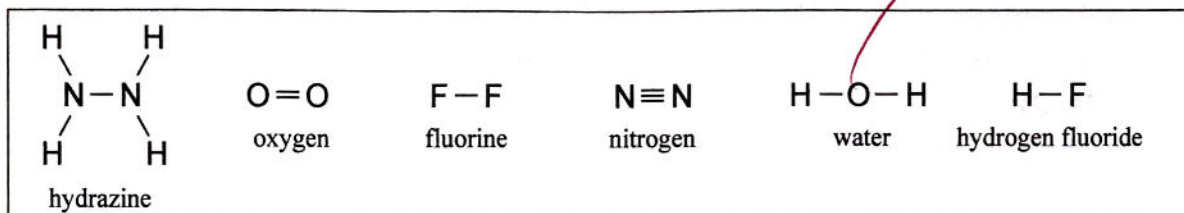
Use the average bond enthalpies given in the table below.

Bond	Average Bond enthalpy /kJ mol^{-1}	Bond	Average Bond enthalpy /kJ mol^{-1}
H–H	436	N–N	158
H–F	567	F–F	159
N–H	391	O=O	498
O–H	463	N≡N	945

Show your working and include appropriate units in your answer.

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QUESTION THREE

ASSESSOR'S
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(a) Complete the table below by stating the type of solid, the type of particle, and the type of bonding (attractive forces) between the particles in each solid.

Solid	Type of solid	Type of particle	Attractive forces between particles
Al(s) (aluminium)	metallic	atoms	metallic bonds
$MgCl_2(s)$ (magnesium chloride)	Ionic	Ions	Ionic bonds
$S_8(s)$ (sulfur)	molecular	molecules	weak intermolecular bonds

(b) Circle the substance which has the lowest melting point.

Al(s) $MgCl_2(s)$ $S_8(s)$

Justify your choice, referring to the attractive forces between the particles of ALL three substances.

Aluminium is a metallic sub The substance with the lowest melting point is S8 (sulfur) This is because. Aluminium is a metallic substance held together by metallic bonds. In a 3D lattice arranged by some free move electron types There of bonds are difficult to overcome due to the non directional name of its structure, a bit of energy is needed to overcome and break these bonds. MgCl2 is an Ionic substance made of Mg and cl⁻ ions held together in a 3D lattice. they are held together by Ionic bonds and are very brittle compared to the strong metallic bonds in Aluminin. S8 has the lowest melting point. molecules are of molecules held in a 3D lattice though weak intermolecular bonds. most of the molecular substances are liquids or gases at

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room temprature. ~~They have to~~ and are very soft and brittle.
They have low melting points as only little
energy is needed to over come and break the
weak intermolecular forces between the
particles in the structure.

(c) Circle the substance which is malleable.

$Al(s)$ $MgCl_2(s)$ $S_8(s)$

Justify your choice by referring to the structure and bonding of your chosen substance.
You may include a diagram or diagrams in your answer.

Aluminium is the substance which is malleable
this is because Aluminium is a metallic substance
made up of atoms in a 3D lattice held together by
strong metallic bonds, surrounded by some free
moving valence electrons. Because further
metallic structure with the substance It is malleable
due to the non directional nature of it's
structure which enable the substance to
be malleable aswell as ductile without weakening
the its structure.

Space for diagram

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A4

Extra paper if required.
Write the question number(s) if applicable.

Subject:	Chemistry		Standard:	91164	Total score:	12

Q	Grade score	Annotation
1	A4	This candidate received a grade score of A4 as it identified an exothermic reaction as well as bond breaking during evaporation, the response further drew an enthalpy diagram, described water as polar and calculated amounts correctly.
2	A4	The grade score of A4 was given as it showed the correct drawing and labelling of Lewis structures, linking the central atom's regions of negative charge to bond angles, identifying molecular polarity and that there was a difference in electronegativity in molecules, as well as identifying most of the bonds broken and made in a chemical reaction.
3	A4	This received A4 for linking solid type, particle type and attractive forces, while also identifying the strength of both metallic bonds and intermolecular bonds, as well as the 3-D lattice nature of aluminium.